Culture: Copying, Compression and Conventionality

CULTURE: COPYING, COMPRESSION AND CONVENTIONALITY

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Social transmission, whereby knowledge is passed on generation after generation by imitation, copying or teaching, plays a central role in cultural evolution. We claim that the key adaptation of cultural information in response to social transmission is *compressibility* -- a property of information inversely related to algorithmic complexity (the length of a system's description). An increase in compressibility is attested in social transmission experiments, e.g. stories and drawings becoming simpler (Bartlett, 1932) or languages becoming structured (Kirby et al. 2008). Those and other studies, however, include in their design two processes that could be responsible for this tendency: *learning* (storing patterns in memory) and *reproduction* (producing the patterns again). In a simple iterated drawing learning experiment we manipulated the impact of memory to explore the causal relationship between this process and the increase in compressibility observed in other studies.

We ran 8 diffusion chains with 22 generations each. Each participant (generation) was asked to examine a target drawing for 10 seconds and then to reproduce it as accurately as possible. The output of a participant was the target for the next one in the chain. In the Memory condition, the target was removed from view after the 10 seconds. In the Copy condition, it remained in full view during reproduction.

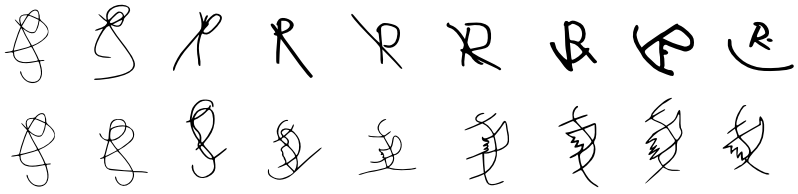

Figure 1. Drawings from representative chains in the two conditions in the experiment (generations 0,1,4,7,10,13,16,19 and 22 are shown). Top: Memory condition. The drawings become simpler and conventionalized. Bottom: Copy condition. The drawings retain their initial complexity and do not become conventionalized.

This manipulation produced striking effects (Fig. 1). Consistent with other studies, the Memory condition drawings became increasingly compressible: they (a) turned graphically simpler and (b) transformed into conventional signals like letters or numbers. The Copy condition drawings, on the other hand, although changing, nevertheless retained their initial level of complexity and did not conventionalize. Figure 2 shows the quantitative results for these two variables.

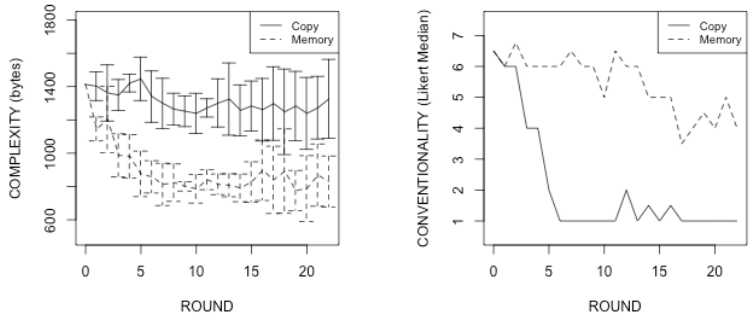

Figure 2. Left: Complexity of the drawings, measured as the size (in bytes) of the files containing each drawing (after scanning, rescaling to the same bounding rectangle area, transforming into vector format and zipping). The effect of Copy versus Memory was highly significant (ANOVA $F(1,6)=62.2$; $p=0.001$). Right: Conventionality of the drawings, as judged by four raters using a 7-point Likert scale. Here too the effect of Copy versus Memory was highly significant (Chi-squared, $p<0.02$ for generations 5 to 22).

This study, first, shows that direct copying can introduce and retain random innovations. Second, it crisply demonstrates that when behavior is transmitted through the bottleneck of *learning* (even if this bottleneck is as tiny as remembering a drawing for a matter of seconds), then we see a cumulative increase in compressibility. Languages must survive transmission through a substantial learning bottleneck, and these results lend further support to the proposal that systematic (and therefore compressible) features of language structure arise naturally out of this process (Brighton et al. 2005).

References

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